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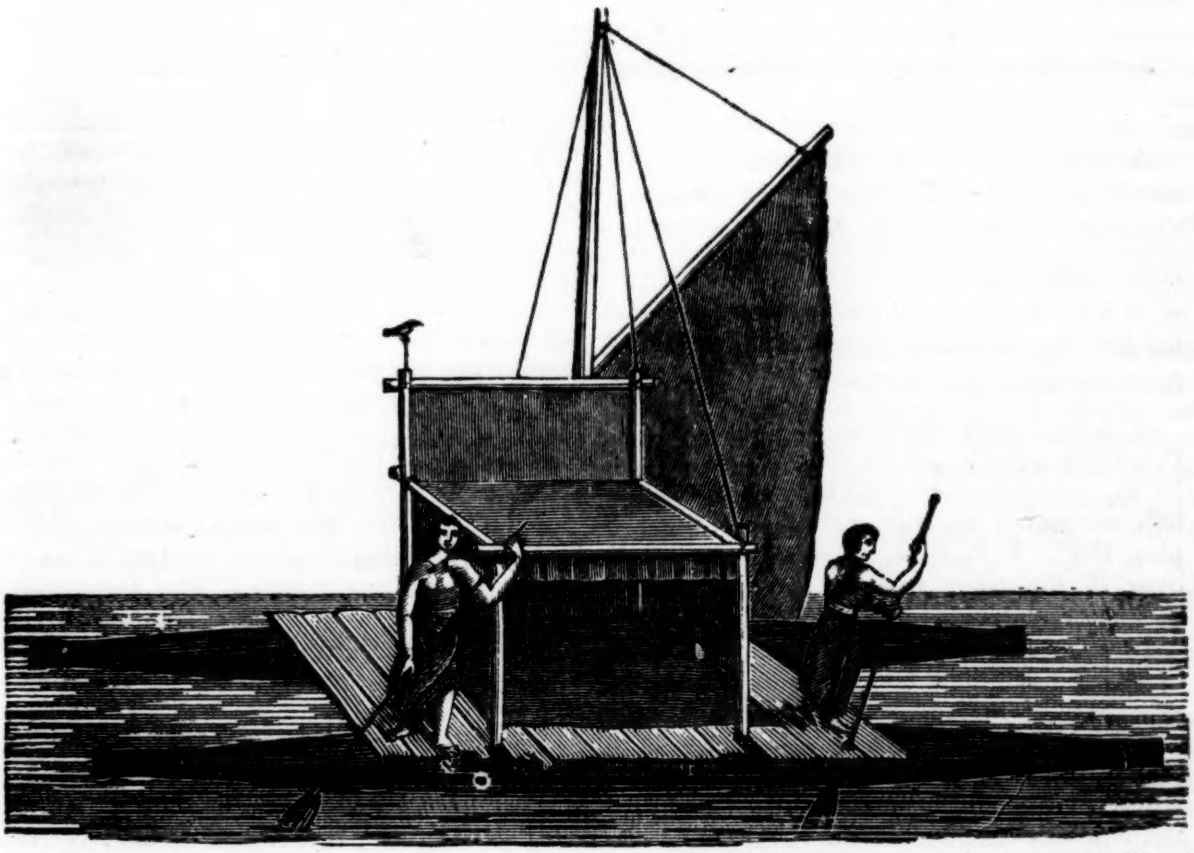
"Science distinguishes a genuine hero from one of those athletic brutes whom, undeservedly, we call by the honorable name. Cursed be the poet who first honored with the title of hero a mere Ajax, a man-killing idiot."—DRYDEN.

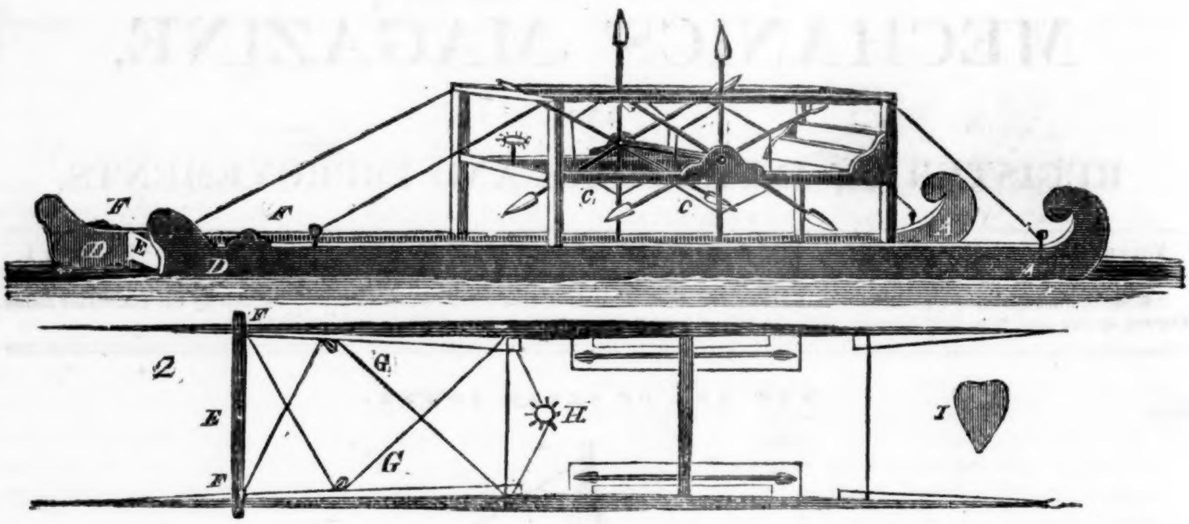
NEW ERA OF STEAM POWER.



A DOUBLE CANOE OF THE FRIENDLY ISLANDS.

The great utility of Mr. Burden's plan, or invention, or adaptation to navigation, (we hardly know what to call it,) has called forth a host of competitors, all desirous of proving that they had the same plan already prepared to come out with when an opportunity should occur which they might consider advantageous. We insert Mr. Canning's claim, and shall, next month, insert some others, introducing now an engraving, handed to us by an esteemed friend, of a boat in use at the Friendly Islands, so long ago as 1798, of a similar construction. It is copied from an engraving in Labillardiere's account of a voyage in search of La Perouse, the French traveller. Monsieur Labillardiere states that a great number of the natives came out to them in boats constructed in a similar manner.

PROGRESS OF STEAM NAVIGATION WITH INDIA.—A steam voyage from India to England, by the Red Sea, seems at last to be really on the eve of taking place. The steamer Forbes has been engaged to start from Calcutta for Suez, the Hugh Lindsay having been pronounced unfit for the purpose. The whole expense, except that of the coals, is to be borne by the Indian Government; while the Calcutta Steam Navigation Committee, will receive all the profits on passengers and all kinds of freight, except letters, the postage of which will be reserved by the Government.



CANNING'S DISPATCH-RAFT.

At page 338, in our last volume, we inserted a letter from Mr. Alfred Canning, (copied from the London Mechanics' Magazine,) asserting his claim to be the inventor of a boat on Burden's plan; we now insert his drawing and description, which we take from the same source.

A A represent floaters. B, the deck. C C, paddle wheels. D D, rudders, connected by E, a board about 7 inches wide, with a hole near each end, into which insert the nipples, F F. F F, G G, till ropes, which pass over H, the tiller wheel. I, cross-section of floater or trunk.

In order to give a due degree of buoyancy to the floaters, I had them hollowed into chambers of 14 inches long, 10 inches deep, and 4 inches wide, leaving solid parts of 3 inches between. This raft was destroyed while afloat on the Seine river, (owing to the culpable negligence of the person who had it in charge,) by a loaded barge, which came in violent contact with it. I shortly afterwards constructed another upon the same principle, but much larger, and instead of floaters, similar to the first, made use of troughs formed of half inch deal boards, which I found also to answer well. When my raft was almost finished, as I was one day trying its rate of going, opposite the Champs Elysees, in company with a friend, and my little son (about three years old), a French steamboat, on board of which was the proprietor and a large party, evidently quitted its original course, dashed with tremendous force upon the starboard quarter of the raft, and broke it up in a twinkling, submerging the deck, upon which the child was placed, who, but for instant vigorous exertion, would, with my friend, have been drowned, as the current runs with extreme rapidity in that part of the river. My friend and the youth were received on board by the steamer. I preferred remaining upon the wreck, which I with difficulty got ashore, at a considerable distance from where the collision took place.

I soon after re-constructed my raft, and substituted for the troughs a double row of small barrels, twenty-eight in number, varying in size, placing the largest the fourth from the bows; these I boarded over with half inch deal boards, forming long staves, which were screwed down to the barrels. The ends of the boards projected beyond the barrels at both ends of the trunks, so as to form stems and sterns. The interstices, between the heads of the barrels and the outside planks, were filled up with a mixture of pitch, tar, cork shavings, saw dust, and resin.

This raft was greatly admired. I had the honor of receiving our veteran hero, Sir Sydney Smith, with a host of distinguished English and French, on board at various times, who all seemed to approve highly of the principle upon which it was constructed—considering that it would insure personal safety in an eminent degree, as it was neither liable to sink nor upset, while its rate of going was much greater than any other sailing craft, and it afforded an incomparably more commodious place for passengers than a boat of ordinary build.

I next contemplated the construction of a still larger raft, to be propelled by steam, but, for the reasons already assigned in my former communication, I was not able to procure permission from the Prefect of the Seine. I soon afterwards sold my raft to Colonel, now General Trobriand, and Mr. Mallet, to run as a pleasure raft upon the celebrated lake of Montmorency.

The 20th of last December, (consequently prior to any account of the raft construct-

ed by Mr. Burden being received in this country,) I commenced the construction of a small raft of the kind for my own use, to run upon the Thames. It is almost finished, and would have been some time back, but for circumstances not connected with the affair. I remain, sir,

ALFRED CANNING.

Crown Coffee-House, Holborn, April 17, 1834.

BURDEN'S BOAT.—We accompanied Mr. Burden in his first trip in his new boat to Albany and Troy. On the 7th of July the boat left the foot of Courtlandt st. at 22 minutes past 7 o'clock. The Erie, which is considered the fastest sailer in the line, was then from four to five miles ahead. Mr. B. continued gaining on the Erie until he nearly reached Catskill, and in a very few minutes would have passed her, but for an accident that occurred to the machinery. The lever of the cut-off-steam valve gave way, and the consequence was a great waste of steam, and reduction of the revolutions of the wheel from 23½ of a ten-foot stroke to 16. Mr. B. finally stopped the boat, and with the assistance of Mr. Snodgrass, Civil Engineer, of Glasgow, (who had the direction of the construction of the cast iron packing, and suggested other alterations that have been adopted,) repaired it, but not so well as to enable Mr. B. to regain the speed he was previously going, namely, about 19 miles an hour.

The time lost in repairing it, and the difference of the speed in consequence of this accident, may be estimated at about three hours—still the boat reached Troy in less than an hour after the Erie. Had the machinery worked well, Mr. B. fully calculated to have made the passage in nine hours.

Mr. B. is about building another boat, 100 feet longer than his present one, the parabolic spindles of which are to be of iron.

The engine was made at Mr. T. B. Stillman's manufactory, Novelty Works, Dry Dock, in this city.

Mr. B., accompanied by numerous friends, has since made another excursion, from Troy to Hudson, and accomplished 18 miles in 65 minutes. He is making some further improvements, which will delay its starting in the regular line two or three weeks.

REPLY OF C. HARRIS TO ARCHIMEDES.

To the Editor of the Mechanics' Magazine:

SIR,—I would, through the columns of your Magazine, inform Archimedes that his "solemn protest" against entertaining any disposition to wound my feelings in a preceding communication, is, as far as I understand that production, entirely gratuitous, although he, no doubt, best knows what his own intentions were. It may be "some alleviation of his trouble" to understand, that unlike a late celebrated protest, it has had the effect only to add to the "no little amusement" which his former communication afforded. Whatever wit lies concealed in his remarks respecting the disturbance of my intellect, being altogether beyond the ken of that intellect, will, for that reason, I trust, form my apology for saying nothing further on that point.

Whether the admission into your Journal of my last communication did or did not operate to the "exclusion of interesting matter from a succession of pages of the Magazine," is a point which the readers thereof will no doubt decide for themselves. Agreeing with A. in his estimation of it, I certainly had not the presumption to think it was very interesting matter. My object evidently was merely to defend myself from what appeared to be the act of an honest, generous opponent, who, deeming me to be in error as to my own invention, (it must be admitted on rather slight premises,) undertook to set me right. As to the *delicacy* and *force* of such remarks as are contained in the immediately preceding quotation from A., I will merely assure him, that to the *exclusive* use of such weapons, and to all the advantages which they can afford him, he is entirely welcome.

Archimedes doubtless well knows, that in my last communication I distinctly state, that "I do not by any means rest on this difference in proportions as a proof that my invention is one *sui generis*, and not identical with Mr. F.'s boat;" and that I then proceeded to describe the most essential points of difference.

With these facts staring him in the face, he has the ingenuousness, the "magnanimity," in the third paragraph of his last communication, to make it appear as if a difference in proportions is the only distinctive mark of my invention as compared with Mr. Fairman's boat.

I have been vain enough to believe that I

possessed a somewhat correct idea of that quality of the mind termed "magnanimity;" but I find to my sorrow that I labored under a mistake, and would here thank Archimedes for the correction; but I would have it understood that I must be allowed the exercise of my own discretion as to the practice of *such* magnanimity as he exhibits *par example*. As a slight reciprocity of the favor, I would tell Archimedes that any shipbuilder's *apprentice* will inform him that the term "fine," when applied to the forms of vessels' extremities, with reference to any peculiarity of model, as was evidently the sense in which I used it, means something very different from "finery." Was it magnanimity, or was it that *other quality*, in this case the only alternative of the former, which caused A. to give a meaning to the term "fine" so *outre*, so foreign from its true signification?

Archimedes says I have "misunderstood him in some trifles," adducing as an instance the *gain* resulting from the swelled sides. He says in his latter, as in his former communication, that the "*gain** in speed, with the same power, was from 4 to 6 miles per hour;" and in proof of that assertion, proceeds, (with what arithmetical consistency I leave others to determine,) to state, "that is, she would go but four miles before the *swell*, and she went six miles afterwards." !! A *boy* now, as I write, at his employment in my counting-room, says that from the above premises the gain could have by no possibility been so much as "from 4 to 6," but only 2 miles. If I have not forgotten my arithmetic, I will venture to say he is right, and that could the shade of the *real* Archimedes rise before him and hear him repeat the assertion of the *American* Archimedes, he would in my opinion be very apt to recommend that boy's return to the pedagogue, to receive, as his first lesson no doubt, a speedy application of a quantum sufficit of birch.

We must all admit that Archimedes' mode of explaining his expression respecting the gain is admirably ingenious, worthy of his *name*. Newspapers contain few phrases more common and well understood, than such as the following, namely, "The profits resulting were from 4 to 6 per cent.;" "the article has advanced from 4 to 5 per cent.;" "from 4 to 4½ per cent. is confidently calculated on;" all three of which expressions, any country lad knows, who reads in a paper the prices of produce, mean neither of them less than 4 per cent. *gain*, advance, or profit, as the case may be. Adopt Archimedes' rules of analysis, and we have two per cent. as the profit in the first case, one per cent. as the advance in the second, and only one half per cent. in the latter case.

Sage of Syracuse! where was thy mantle when thine own son, in this age of degeneracy, threw out, under the protecting ægis of thy name, these portentous *new-lights*, threatening sudden destruction to the long established principles of thy favorite pursuits?

But to respite Archimedes' famous *solution* of so plain, so very common, and well understood a phrase, as is used by him to express the gain, still it of necessity results, from the original speed, 4 miles, and the improved speed, 6 miles, as are now given by him, that the *swell*, namely, "the angle of *resistance*," (the very words of A. in relation to the inner curves,) conferred a gain of 50 per cent.!! *Credat Judæus!* and so may Archimedes, no doubt, in all sincerity; but, sir, I cannot constrain my mind to admit every startling proposition brought before it, even if others, with "*names* of learned length," happen to believe it.

In some cases, and this from its nature is one, (withont any implied disparagement to A. and his friend,) sound and sufficient reasoning is requisite to convince the understanding, and I would therefore humbly beg Archimedes, (surely his pride of *name* will not allow a refusal,) to demonstrate, for the benefit of my obtuse "intellect," how that which, as soon as applied, is in itself "an angle of *resistance*," an obstruction, can, merely by the application thereof, diminish resistance which itself alone creates—remove obstruction, an effect of which it is the cause, or in any way add to that speed which from its very nature it must be at the same time retarding.

Archimedes states that "Mr. F. *supposed** that as the water was thrown back from the wheel, by giving it a diverging passage, it would leave the boat more freely," and remarks "perhaps he was wrong." A. requires only a little practical acquaintance with the subject to become perfectly convinced, that, however plausible this divergency may appear on paper, it is quite another affair in water.

I am informed by A. that "there are times when there is not a six-knot sailing breeze in the sound, and that perhaps Mr. F. took such a time." It appears from the text that Mr. F. made *several* trips, carrying passengers. "Perhaps" also, old fathers

* Italicised by C. H.

* Italicised by C. H.

Neptune and Æolus were induced to form a coalition, and mutually engage that there should be no troublesome *swell* kicked up on the several days appointed for the running of Mr. F.'s boat. After A.'s display of the new-fashioned magnanimity, I cannot, of course, rely upon his candor as to admitting the correctness of my "statements" referred to by him, and therefore must, of course, forever lament that my invention cannot obtain the immortalizing approbation of one whose powers of "intellect" are so transcendently great as to make a "*gain* of from 4 to 6 miles" expressible by the numeral digit 2.

A.'s assumption that he has been a source of trouble to me, however indicative it may be of a little harmless vanity, is equally gratuitous with his solemn protest; for I can assure him, as I have already done, that he has literally amused me, amused me only, and that whether I "hear again" from him or not is a matter of indifference to me, and a point which I leave entirely to his own discretion.

I remain, sir, very respectfully, yours,

CHARLES HARRIS.

Norfolk, Va., July 1, 1834.

AERIAL STEAMBOAT.—We find the following in the Cincinnati Daily Gazette.

Mr. Editor,—Perhaps it is not generally known, that one of our ingenious citizens has invented, and has now in preparation, the *model* of an *aerial steamboat*, in which he proposes to ascend.

Although but little expectation of the success of the experiment is entertained by the writer of this article, it is worthy the attention and examination of the scientific. The inventor, Mr. Mason, is very sanguine, having already made (to him) a satisfactory experiment.

The boat is about ten feet long, the ribs being covered with silk, in order to render it very light. The engine, of two horse power, is placed in the middle, and turns four vertical shafts projecting over the *bow* and *stern*, into each of which are fixed four spiral silken wings, which are made to revolve with a sufficient velocity to cause the vessel to rise. Over the whole is fixed a moveable silken cover, designed to assist in counteracting the gravitating force, at the same time tending to assist in its propulsion forward.

The whole boat, including the engine, weighs 60 pounds, and has cost about $300. It is the design of the *inventor* to *attempt* an aerial excursion, of which due notice will be given. J. L.

SUCCESS OF STEAM-CARRIAGES ON COMMON ROADS.—These wonderful machines are now constructed with sufficient mechanical skill, amount of power, safety, and general efficiency, to insure their successful employment on any good road; and it is certainly time for our capitalists to turn their attention to them as legitimate objects of support, and as offering the means of a profitable investment. From the earliest developement of the capabilities of steam, as applicable to purposes of locomotion, on properly constructed roads, we have carefully watched the progress made by different inventors, and have on many occasions borne testimony to the unceasing efforts of two of the most persevering and deserving among them: of two who have from time to time promised less and performed more than any of their contemporaries—we mean Col. Maceroni and Mr. Hancock. On Saturday we had a trip on the Edgeware road, with the second coach constructed by the gallant Colonel. Starting from the Paddington Wharf, No. 19, we proceeded on the road in the most surprising style, the coach being turned, checked, stopped, or having its speed increased, under the complete command of the conductor. About three miles out we passed a stage coach, whose four horses were put to their utmost speed, with a comparative velocity to that with which the stage coach would have passed a waggon, our rate being at that time about 18 miles an hour. Soon after this we ascended Windmill-hill with perfect ease; although, in consequence of the road undergoing repair, the part we had to ascend was cut into deep ruts, and covered with dry soil and dust from three to six inches deep—forming, perhaps, the most uncertain and disadvantageous fulcrum on which the wheel of a steam carriage could ever have to act. We arrived at the Welch Harp Inn, which is several perches over the five miles from our starting place, and turned the coach in the direction of Paddington, in precisely twenty minutes; having performed the distance, inclusive of stopping at the turnpike and on two other occasions, and despite the bad condition of Windmill-hill, at the extraordinary average rate of fifteen miles an hour. Our return occupied the same period of time; and after this completion of the trip, we made the round of Paddington Green to gratify some gentlemen who had not arrived in time to witness the more extensive trial. Among our fellow-passengers on these occasions were Jerome Buonaparte, ex-king of Westphalia, Prince Jerome his son, the Duke de Montfort, the Marquis Azolino, M. Vigne de Marveille, and other distinguished foreigners.—[London Morning News.]

Col. Maceroni has addressed the following letter to a morning paper:

Sir,—You certainly have made a mistake in saying that the coach, on Saturday last, went at eighteen miles the hour, when it overtook and passed the stage, whose four horses were "put to their utmost speed, with a velocity comparative to that with which the stage coach would have passed a waggon."

Wyatt, of the Watford and Aylesbury coach, the one to which you refer, is very angry at your asserting that his fine team of horses were overtaken and passed in the manner you speak of by the steamer, when the latter did not perform more than 18 miles the hour! Wyatt knows the steamer well; he was once beaten by it going up Windmill-hill; and he says—and I say—and all the others say, that when the steam carriage overtook him, and passed him on Saturday, it was undoubtedly at a pace of more than 24 miles the hour.

We have many times done two miles in five minutes, and you shall see it done again whenever you are so disposed.

You show that the speed of the whole ten miles, including several stoppages and the turnpike, &c., was above fifteen miles the hour. Surely to overtake and pass a team of four fine horses at their "utmost speed," as we did, must have required more than eighteen!

But to set the matter at rest in your mind, I will keep a seat for you in the carriage on an occasion which will offer in a few days, of putting to the test, at their utmost speed, a chosen team of horses, a fourteen mile heat, on the most hilly and softest road out of London. I have the honor to be, sir, your most obedient servant, FRANCIS MACERONI.

Wharf 19, Paddington Green, May 26, 1834.

On the Phenomena of Flame. By J. O. N. RUTTER, ESQ. [From the London Mechanics' Magazine.]

"As in mathematics, so in natural philosophy, the investigation of difficult things by the method of analysis ought ever to precede the method of composition. This analysis consists in making experiments and observations, and in drawing general conclusions from them by induction, and admitting of no objections against the conclusions but such as are taken from experiments, or certain other truths. For hypotheses are not to be regarded in experimental philosophy."—[Sir Isaac Newton.]

The design of the following paper is to bring together a variety of experiments which may be considered as illustrative of the phenomena of flame. By applying to them the canon of philosophical research so beautifully described by Newton, we may, perhaps, arrive at conclusions at once instructive and satisfactory. It is very agreeable, and sometimes very convenient, to take shelter beneath the influence of great names. This love of ease, when the investigation of an intricate subject is concerned, tends very often to perpetuate error. Whenever acknowledged difficulties present themselves, they ought to be fairly met, rigidly examined—and, if possible, immediately removed. A course the very opposite to this is frequently pursued by very excellent and very learned men; among whom are some of the most popular scientific writers of the present day. With book-makers it is a common practice to transfer the opinions, and, in many cases, the very words of others, to their own columns, without examination; and, not unfrequently, without acknowledgment.

As the papers of Sym and Davies on flame, referred to by Dr. Thompson, in his Treatise on "Heat and Electricity," 8vo. London, 1830, p. 310, are not accessible to me, I have no means of ascertaining whether the following experiments have or have not been already described. If I have been anticipated in the whole of these investigations,* I can see no reason for rejecting or undervaluing, on that account, the information they supply.

1. If a piece of wire-gauze be brought down gradually upon the flame of a taper, or candle, the section of the flame, when viewed from above through the wire-gauze, will appear as a ring of light surrounding the wick, but not in contact with it.

2. A jet of coal gas will present a similar appearance. The orifice of the jet may be very distinctly seen in the interior of the flame.

3. If the wire-gauze be brought down in the way already mentioned upon a flame of coal gas, issuing from an Argand burner, the section of the flame will exhibit two distinct rings of light, and the thickness of the burner will determine the distance between the rings.

4. If an Argand lamp, with a wick supplied with oil, be employed, the thickness of the wick will determine the distance between the rings.

5. When the air is excluded from the interior of an Argand burner, the flame, whether it be that arising from gas or oil, which was previously cylindrical, assumes a conical form. Let the wire-gauze be brought down upon this flame, and there will be, as in the case of the taper, or the jet, (1, 2,) one ring of light corresponding with the exterior surface of the wick, or burner, (3, 4.)

6. The flames of alcohol, and of hydrogen gas, present in every respect the same phenomena as those described (1, 2, 3, 4, 5,) excepting, of course, in the quality of the light.

7. Phosphorus, if inflamed in contact with the atmosphere, and the wire-gauze brought down upon it, exhibits a ring of light. The experiment requires a little caution and dexterity. The opacity of the interior of the flame may, however, be very distinctly recognized.

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* I observe that Mr. Watson, Mechanics' Magazine, No. 551, page 362, has anticipated one of my experiments. I am hence induced to hold them all with a loose hand.

8. If we take about three fourths of an inch of wax taper, insert it in a piece of glass tube the same length, employing as a foot to the taper so inclosed a disc of cork, sufficiently large to keep it steady; then, in a saucer or evaporating dish, coil some filaments of lamp cotton, so as to form a ring about two inches in diameter, and three fourths of an inch in height; saturate the ring of cotton with alcohol, light the taper, place it in the centre of the ring and inflame the alcohol, the taper will be extinguished. The heat in the interior of the flame of the alcohol will be sufficiently intense to vaporise the wax, which vapor will be decomposed and inflamed at the summit of the alcoholic flame, imparting to it a characteristic brilliancy; but the wick of the taper will not be inflamed if the process be properly conducted. To insure success in this experiment, we must guard against any agitation in the surrounding atmosphere, by moving about the room, opening or shutting doors, or breathing too freely in the immediate vicinity of the alcoholic flame. After observing all these precautions, we shall probably find that the flame will be in a continued flutter, occasioned by a current of rarefied air, and the taper will be alternately extinguished and relighted, just in proportion as the unsteadiness of the flame prevails or subsides.

9. Instead of a taper (8), if we place a piece of phosphorus in a small metallic spoon,* inflame it and pass it into the interior of the alcoholic flame, the phosphorus will be extinguished; suddenly withdraw it, it will inflame; pass it again into the interior, and it will again be extinguished.

The phosphorus, as already remarked of the taper, may be vaporised; and the vapor will become luminous as it enters into combination with oxygen at the summit of the alcoholic flame. Should it happen that the phosphorus has not been properly dried, small particles of it will be thrown out on every side: these will inflame the instant they come in contact with the external atmosphere.

10. We may vary this experiment by placing in the interior of the alcoholic flame (9) a small metallic cup,† containing alcohol, ether, or spirit of turpentine. These materials may be vaporised, but they will not flame in the cup as long as the alcoholic flame preserves its conical form.

11. If phosphorus (9) be placed in the centre of the flame of an Argand burner, (3, 4,) to which atmospheric air has access, it will inflame. If the further ingress of air be prevented, the flame will become conical (5), and the phosphorus will be extinguished.

12. The result will be still more instructive, if we repeat the last experiment in an Argand burner supplied with coal gas, the ingress of air to its interior being prevented. Let the phosphorus be ignited and passed into the interior of the gas flame, the phosphorus will be extinguished. Turn off the gas, the phosphorus will be inflamed; turn on the gas, that will be inflamed, whilst the phosphorus will be again extinguished (10). If we employ alcohol, ether, or spirit of turpentine, in an Argand burner, supplied with oil, or coal gas, the results will be more uniform and satisfactory than with a large flame of alcohol, for the reason already stated (8).

13. A lighted taper placed in the interior of the flame of an Argand burner will continue to burn so long as air has access to it: exclude the air (5), and the taper will be extinguished. We may vary this experiment by employing a jet of coal gas instead of the taper. The result will be the same in both cases.

14. If a coil of platinum wire be held above the flame of alcohol, the wire will become incandescent. If we pass the wire into the interior of the flame, its incandescence will cease. In this experiment the effect will be more intelligible if we employ a spirit lamp with an Argand wick. The incandescence of the wire may be determined or prevented, by the admission or exclusion of air (11).

15. Instead of an Argand wick we may employ a common fibrous wick of cotton, say one inch in diameter, and it may be supplied with tallow, oil, or alcohol. The phenomena will be the same as those already described (5, 8, 9, 10.)

16. If a stream of oxygen gas be projected from below into the interior of a conical flame (5, 6, 15,) we shall observe the unusual phenomena of one flame within another.

17. A stream of oxygen gas, or of atmospheric air, projected upon any of the materials before mentioned, viz. phosphorus, ether, alcohol, spirit of turpentine, a jet of coal gas, or a taper, will produce an inflammation; but the inflammation will continue in the respective materials only so long as the supply of gas, or of air, is maintained.

18. If any of the materials just enumerated be placed in actual contact with the flames of tallow, oil, alcohol, or gas, whether

* A spoon for this purpose may be conveniently formed by flattening one end of a piece of copper wire.

† For cheapness and convenience, say part of a child's thimble.

interiorly or exteriorly, inflammation will ensue; but the combustion of the respective materials will be less perfect and less energetic when enveloped in the flame of some other body than when they are inflamed, under ordinary circumstances, in contact with atmospheric air.

19. The flame of an explosive mixture of coal and oxygen gases is of a pale blue color, and the greater the proportions of oxygen, within the limits of saturation,* the smaller is the flame, and the fainter is its hue, as compared with an equal volume of coal-gas when burning in the usual way. Similar phenomena present themselves in an explosive mixture of coal gas and of atmospheric air. In the latter case, the color of the flame is somewhat deeper.

20. It is almost unnecessary to remark, that the flame of an explosive mixture of oxygen and hydrogen gases is of so pale a color as to be scarcely perceptible in daylight. This is not its most remarkable quality.

21. If a stream of hydrogen gas be ignited at the point of a jet, by bringing down upon it a piece of wire-gauze (2), we may ascertain that the flame is hollow. If a stream of oxygen gas be projected from a similar jet, in the same direction, and in immediate contact with the hydrogen, we shall find that, notwithstanding the additional supply of gas, (the proper proportions being half a volume of oxygen to one volume of hydrogen,) the flame will be immediately very sensibly diminished in size, and it will no longer appear hollow. Further: in the flame from hydrogen alone, the greatest intensity of heat will be found near to its extremity, at the apex of the cone. It is not so with the oxy-hydrogen flame—the point of greatest intensity in that being near the base of the cone, where the greatest quantities of the two gases first enter into chemical union.

22. The analysis of coal gas teaches us that when it is of good quality, (sp. gr. 475 h. 550,) each volume will require for its complete combustion nearly two volumes of oxygen: one volume of oxygen, combined with an equal volume of carbon, producing carbonic acid; the other volume of oxygen, by its union with two volumes of hydrogen (condensed into one volume as it exists in carburetted hydrogen,) forming water.

23. The analysis of coal gas also enables us to understand the habits of explosive mixtures, and especially those of carburetted hydrogen (fire damp) and atmospheric air. Thus, when the relative proportions of inflammable gas and of air are as one volume of the former to five volumes of the latter, the mixture is not explosive; but if the quantity of air be gradually increased from five to ten, or even twelve volumes, the mixture detonates with increasing violence at every additional volume of air, up to the point of saturation.*

24. That mixtures of explosive gases, whose relative proportions are adapted to form most readily new compounds, will detonate with the greatest violence; and *vice versa.*

25. Explosive mixtures of coal gas, or carburetted hydrogen, and of oxygen, are subject to the same laws as mixtures of the same inflammable gases with atmospheric air. The former explode more uniformly and more promptly than the latter. This is a result we may expect, since in the former instance the particles of inflammable gas and its supporter must be in more intimate union than can possibly happen in the latter instance, through the interference of the azotic gas present in atmospheric air.

26. Those mixtures of explosive gases inflame the most readily through narrow tubes, and the interstices of wire gauze, whose relative proportions are best adapted for forming new compounds. We have no difficulty in understanding how it is that explosive mixtures inflame so readily in narrow tubes and in close vessels, if we bear in mind that the elements of combustion are arranged, in such mixtures, under the most favorable circumstances; and hence they require no aid from fresh accessions of oxygen externally applied.

27. If we apply a blow-pipe to the flame of a candle, a lamp, or a jet of coal gas, we shall find a greater intensity of heat will be obtained by projecting a stream of air across the flame near its base, than by projecting

* I employ this term for want of a better. By the limits of saturation, I mean those proportions of oxygen with coal gas most favorable to inflammation or explosion.

* See preceding note. As a familiar illustration of these phenomena, we may suppose 100 cubic inches of coal gas to be mixed with 500 cubic inches of atmospheric air. The mixture will not be explosive, because it will not contain a sufficiency of oxygen to support its inflammation—500 inches of air containing only about 100 inches of oxygen —and 100 inches of coal gas requiring 200 inches of oxygen for its complete combustion. If, however, 100 inches of coal gas be mixed with a thousand inches of air, the mixture will be explosive, since it will contain the relative proportions of the inflammable gas, and the supporter most favorable to inflammation or explosion. We know that when coal gas, or the fire-damp of mines, is mixed with air in proportions of one volume of the two former to any number of volumes intermediate between 5 and 10 of the latter, the mixture is explosive, but it is only so to a certain extent. When the proportions of air exceed 12 or 12½ volumes of inflammable gas, the mixture is not explosive—an excess of oxygen having, in this respect, the same effect as its deficiency.

a similar stream across the upper portion or apex of the flame. We may obtain satisfactory proofs that these views are correct, if we consult any intelligent artificer who is in the habit of using the blow-pipe.

28. If we pass a piece of wire gauze across the base of a jet of coal gas (in the blue portion of the flame), the gas will continue to burn above the gauze as well as below it, and no free carbon will be deposited on the under side of the gauze; nor will there be any set at liberty from the flame above the gauze. By passing the gauze upwards, and holding it near to the apex of the flame, we shall perceive a different result. Free carbon will be deposited in abundance on the under side of the gauze, the flame above it will be extinguished, and, as the gauze becomes heated, a dense vapor of carbon will pass through, which may be inflamed.

29. This experiment may be varied, by substituting for a jet of coal gas the flame of a wax taper, a common candle, or an oil lamp. Instead of wire gauze, if we pass a piece of writing paper, or card board, into the blue portion of the flame, it will not be tarnished; we may repeat the same process about half way up the flame, and with the same result; but if we ascend towards the apex of the flame, the paper or the card will be blackened by the deposition of free carbon. Finally: if we hold the paper or card above the flame, it will not be blackened, a proof that no free carbon escapes into the atmosphere.*

30. An equal quantity of oxygen will combine with a given quantity of coal gas, or of carburetted hydrogen gas, under circumstances very dissimilar, and producing in one case a very feeble, and in the other a very brilliant light. Thus, two volumes of oxygen being mixed with one volume of coal gas, and the mixture inflamed as it issues from a jet, the flame will be small, of a pale blue color, and afford a very feeble light (19). One volume of coal gas, with ten volumes of air, will produce a similar effect, the flame being of a somewhat deeper color (19). When coal gas is inflamed in an atmosphere of oxygen gas, the flame is larger than ordinary, and the light from it exceedingly brilliant; and, as already mentioned, the same quantity of oxygen combines with a given quantity of the inflammable gas, as in the two former instances. The resulting compounds are alike in quantity and in character in each case (22).* The phenomena that accompany the combustion of coal gas, under ordinary circumstances, for the purpose of artificial illumination, are so well known that they can need no particular description.

31. If the flame of an explosive mixture of coal gas and oxygen, or atmospheric air, be treated with wire gauze or card board, as already described (28, 29,) it will be found that no free carbon will be liberated at any part of the flame, either within it or above it.

32. If there be projected upon a flame of coal gas a strong current of air, the flame will immediately be diminished in size, and it will exhibit all the properties of the flame of an explosive mixture (19, 31.)

33. In an attentive observation of the combustion of an explosive mixture of coal gas, or carburetted hydrogen and atmospheric air, within a safety lamp, we shall be sure to notice how speedily the flame from the wick will be extinguished. It will not, I suppose, be denied that this is occasioned by the absence of oxygen.

34. It may be ascertained by mere inspection, that the flame of the mixture within the lamp is hollow. Towards the top of the lamp the flame will sometimes assume a more brilliant aspect than at any other part. It more frequently happens, however, that free carbon (smoke) will escape from the top of the lamp.

35. If it be inquired whence arises the luminosity of the flame at the upper part of the lamp, or, in its absence, the free carbon (smoke), already mentioned, I reply, that whilst the explosive mixture burns within the cage, the heat evolved will be sufficient to carry on the evaporisation of the oil in the reservoir of the lamp. This vapor occupying, in a partial degree at least, the interior of the flame, will be converted into oil gas; and if there be present in the explosive mixture a large proportion of oxygen, a part of the gas will be decomposed, exhibiting its peculiar brilliancy (45). But should there be only a small proportion of oxygen present, the nascent oil gas will not become luminous, although it may be decomposed, and hence the separation of free carbon (smoke).

36. That the view here taken of the vaporisation of the oil is correct, may be satisfactorily proved, by employing in a similar mixture of explosive gases two safety lamps,

* The process of introducing and withdrawing the paper or card must, of course, occupy only a moment. The flame employed should be so trimmed as to be free from smoke.

* Such frequent reference is made to coal gas, because now that gas light is making rapid progress among the provincial towns of this kingdom, there will be greater facilities than formerly for obtaining it in researches of this kind. I object to the employment of the generic term, carburetted hydrogen, in a sense synonymous with coal gas.

one with the wick and the reservoir of oil adapted in the usual way, the other with a temporary wax wick attached to the reservoir, but without any oil therein. The re-lighting of the wick, on the re-admission of oxygen to the lamp containing oil, is, under these circumstances, perfectly intelligible (16, 17.)

37. An explosive mixture will burn tranquilly within a safety lamp, without raising the wire gauze to a temperature that will communicate inflammation to the surrounding atmosphere of explosive gases, so long as that atmosphere remains undisturbed; but if the lamp be exposed to a current of the explosive gases, the flame within the lamp will be driven against the wire gauze at the side opposite to that whence the current flows, and then the gas will become sufficiently heated to permit the flame to pass through, or to communicate inflammation to the external atmosphere.

38. Those explosive mixtures, the proportionals of whose elements assimilate the nearest to two volumes of hydrogen and one volume of oxygen, yield by combustion the greatest quantity of heat from a given volume of the mixture. Hence it is easy to understand that the relative proportions of a third element, as carbon in carburetted hydrogen, and azote in atmospheric air, determine the specific temperature of the mixtures in which they may be present.

39. The security afforded by the use of a cage of wire gauze in an explosive atmosphere is not entirely due to the radiating properties of the metal. The temperature, at any particular part of a large cylindrical film of flame of an explosive mixture, burning tranquilly within a safety lamp, will be very inferior to that arising from the combustion of the same materials under different circumstances. The vaporisation of the oil (35) will engage a portion of the heat given out by the combination of the gases. But there is another condition that demands especial notice. Whilst a current of the explosive mixture is flowing *inwards* through the interstices of the gauze at the base of the cage—which current, from its temperature and direction, cannot possibly communicate inflammation to the external atmosphere—a similar current of non-explosive materials (aqueous vapor, carbonic acid gas, free carbon, and azotic gas,) must be necessarily flowing *outwards* near the top of the lamp.* When these tranquil currents are disturbed by a sudden rush of the explosive atmosphere, or of comparatively fresh air, then it is that explosion ensues.

40. The phenomena that accompany the tranquil combination of explosive mixtures, at a temperature below that which is sufficient to inflame them, are so numerous and so interesting, especially when viewed in connection with Mr. Faraday's late researches into the action of platina upon gaseous bodies, that they will require a separate notice.

41. Having thus enumerated with a minuteness that it is feared will be considered by some as unnecessary, a variety of phenomena connected with flame, it now remains that we should inquire if the facts eliminated support and illustrate the theory of flame, as announced by Sir H. Davy, and the views which are advanced by other writers, some of whom stand deservedly high in the scientific world.

42. It is stated by Davy, in his Treatise on the Safety Lamp, 8vo., London, 1825, p. 46: That "the flame of combustible bodies, in all cases, must be considered as the combustion of an *explosive mixture* of inflammable gas, or vapor and air: for it cannot be regarded as a mere combustion at the surface of contact of the inflammable matter; and the fact is proved by holding a taper or a piece of burning phosphorus within a large flame made by the combustion of alcohol, the flame of the candle, or of the phosphorus, will appear in the centre of the other flame, proving that there is oxygen even in its interior part."

Dr. Ure, Dict. Chem., 4th edit., London, 1831, has quoted verbatim the above paragraph, Art. Combustion, p. 357, without acknowledgment. He has also enriched his pages by copious extracts from Davy's work throughout the same article.

Dr. Graham, Chem. Catechism, 2d edit., London, 1829, Art. Combustion, p. 589, also quotes without acknowledgment a part of the paragraph. In a note there is the following piece of information: "The form of flame is conical, because the greatest heat is in the centre of the *inflammable mixture*."

Dr. Thompson says, in his admirable Treatise on Heat and Electricity, 8vo., London. 1830, p. 309: "Flame is the rapid combustion of volatilized matter. The tallow or the wax is melted and drawn up to the top of the wick of a candle. Here it is boiled and converted into vapor, which ascends in the form of a column. This vapor is raised to such a temperature that it combines rapidly with the oxygen of the surrounding atmosphere, and the heat evolved

* The comparatively low temperature of the flame of explosive mixtures present in coal mines, is doubtless owing, in a great measure, to the vast quantities of azotic gas contained in those mixtures.

is such as to heat the vapor to whiteness. Flame, then, is merely volatile combustible matter heated white hot. The combustion can only take place in that part of the column of hot vapor that is in contact with the atmosphere, namely, the exterior surface. The flame of the candle, then, is merely a thin film of white hot vapor, enclosing within it a quantity of hot vapor, which, for want of oxygen, is incapable of burning."

Dr. Lardner, Cab. Cyc., Treatise on Heat, p. 358, seems to entertain similar views to those expressed by Dr. Thompson. By the frequent interchange of the terms "gas," and "vapor," the passage in the Cab. Cyc. is, however, rendered somewhat obscure.

43. If we observe with attention the flame of a combustible body with whose habits we are familiar, say, for example, a common tallow candle, it will be found to exhibit the following phenomena. The tallow being liquified by the proximity of a burning body, rises, by capillary attraction, between the filaments of the wick. As it approaches the flame it is converted into vapor, from which state it readily passes into that of gas. The flame not being in actual contact with the wick (1), the vaporisation of the tallow goes on simultaneously at every part of the wick surrounded by the flame. The blue portion of the flame, at its base, as well as the fainter film of blue that surrounds its other parts, denote the chemical union of carburetted hydrogen and oxygen gases (19, 30, 31.) As this union is a continuous process, accompanied by the evolution of heat, a temperature is speedily attained of sufficient intensity to decompose a great proportion of the nascent inflammable gas. By this decomposition successive portions of carbon are separated from hydrogen. The hydrogen combines with oxygen, forming water; the carbon at this elevated temperature becomes luminous, and combining also with oxygen, yields carbonic acid gas (22).

44. It will be seen that I do not agree with Dr. Thompson (42), who maintains that the flame of a candle "is merely a thin film of white hot *vapor*." We are accustomed to say, that the vapor of certain bodies, as of alcohol, or ether, is inflammable, but I consider the inflammability of these vapors is due entirely to the facility with which they are convertible into gases under certain specific conditions, and the influence of a certain temperature.*

45. If the view we have taken be correct (43), it seems that the combustion of a tallow candle involves a somewhat complicated, yet, if carefully analyzed, an exceedingly beautiful process. It is a conical film of luminous matter (1), changing gradually upwards, from blue to white. It contains, in its interior, nascent inflammable gas; but no oxygen (15, 16.) At the very base of this film of flame, at a temperature which may be termed specifically its own, we may perceive indications that a chemical union is going on between carburetted hydrogen and oxygen gases; aqueous vapor and carbonic acid gas being projected from the flame at this part.* The supply of inflammable gas from within being constant and regular, and an equally uninterrupted supply of oxygen being established by the rarefaction of that portion of air in the immediate vicinity of the flame, the heat given out by the sudden union of one portion of inflammable gas with oxygen is sufficient to decompose a large portion of the same material. To the latter part of the process are we indebted for the illuminating properties of the flame. Hence also those important distinctions perceptible in different parts of the same flame (30).

46. The flame of combustible bodies cannot, therefore, "in all cases be regarded as the combustion of an *explosive mixture* of inflammable gas, or vapor and air," but as the tranquil and progressive combination of inflammable gas with oxygen. The combustion of explosive mixtures differs from that of a common candle or coal gas, (19, 20, 30, 31, 43, 44, 45,) inasmuch, that in one case there is an immediate combination of all the inflammable gas with oxygen; in the other, a part only so combines, whilst the greater portion undergoes decomposition previous to its ultimate combination (29). The resultants are the same in both cases; but the conditions that produce them essentially differ.

47. What has been said respecting the flame of a candle may be applied, without

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* Some have maintained that the bodies we designate gaseous are nothing more than vapors. I here only speak of things as we find them. If gases are vapors, we know them to be more complex and refined, as regards the arrangement of their particles, than vapors, in the popular acceptation of the term. Should it be objected that vapor of certain inflammable bodies detonate, if mixed with oxygen, in the same way as explosive mixtures of gases, I have only to reply that the detonation is the result of the sudden and spontaneous evolution of gas, and its re-union with the oxygen present. These processes may be the work only of 1-100th or 5-100th part of a second.

* To ascertain this fact by experiment, the following simple means may be employed: If a piece of cold glass or polished metal be held near the blue part of the flame, aqueous vapor will be projected upon it. 2. If a drop of a saturated solution of lime (lime-water) be held at the end of a small glass rod or tube near the blue flame, the water will become turbid—carbonic acid gas combining with the lime and separating it from the water. This latter experiment must be the work of a moment, or we may be deceived by simply vaporising the water.

difficulty, to the flame of those combustible bodies with which we are familiar in the ordinary affairs of life. The flame of a tallow candle, an oil lamp, and a coal fire, present not only similar, but identical phenomena. The flame of coal gas differs from each of the preceding. In the three former there is a vaporisation of the elements of the combustible body,—a spontaneous, or, if I may employ the term, an extemporaneous transition of this vapor to gas; then follows inflammation, decomposition, and re-composition. In the latter case, the gas being previously generated, inflammation is the first stage in the process of combustion: the subsequent stages are identical."*

48. That all the vapor arising from a combustible body is not, excepting under particular circumstances, converted into gas, is abundantly evident by the free carbon (smoke) that arises from a candle, a lamp, and a coal fire. Equally evident is it that certain conditions must be observed in effecting the combination of all the elements of a previously prepared gaseous body with oxygen. This we learn by the free carbon (smoke) given off from coal gas, when too much is admitted to the burner.

49. Those bodies which contain a large portion of carbon, as compared with their other elements, require different management from those whose elements of inflammability assimilate in more exact proportions. It will be sufficient to mention, and to place in juxta-position,

Ether - -	Spirit of turpentine.
Sperm oil - -	Coal tar.

In ether and in sperm oil, hydrogen and carbon exist in such proportions, that they readily pass through the several stages already described (47), and form with oxygen new compounds.† Spirit of turpentine and coal tar, containing, on the contrary, an excess of carbon, require a different treatment to effect their entire combination with oxygen.

50. It is inexplicable why Davy employed a larger flame of alcohol in his researches in preference to a smaller one, since it is so difficult to conduct with the former a fair and accurate experiment, whilst with the latter the results are uniform and conclusive (8, 12); we have no difficulty in ascertaining that flame is hollow (1, 2, 3, 4, 5, 6, 7;) we have the most conclusive evidence that oxygen exists not in the interior of flame (8, 9, 10, 12, 13, 14, 15, 16, 17); not even in that of explosive mixtures (33). And equally certain is it that the habits of explosive mixtures are very unlike those exhibited by combustible bodies under ordinary circumstances (19, 20, 21, 23, 30, 31.) Further, we may not only satisfy ourselves that the flame of a candle or lamp is conical and hollow, but we may ascertain that it does not consist only of a thin film of luminous matter, and that combustion takes place only at the surface where the inflammable gas comes in contact with oxygen. Thus, the flame from an Argand burner, when air has access to its interior, is not only cylindrical, but hollow, *i. e.* it consists of two concentric cylinders, or films of luminous matter (3, 4,) whilst the flame from the same burner, when air is excluded from its interior, consists only of one cylinder, or an external film (5). Difficult as it may be to understand how so eminent a philosopher as Davy could have erred in relation to this subject, I think we have no alternative but to reject his theory of flame, since it is wholly unsupported by fact and experiment. This will be done, I have no doubt, by all who, unbiassed by prejudice, and unawed by great names, will take the trouble to investigate the matter for themselves. J. N. O. Rutter.

Lymington, Hants, May 14, 1834.

The Steam-Engine, the Cotton-Spinner's Best Friend. [From Mr. Tuffnell's Report to the Central Board of Factory Commissioners in England.]

Of all the common prejudices that exist with respect to factory labor, there is none more unfounded than that which ascribes to it excessive tedium and irksomeness above other occupations, owing to its being carried on in conjunction with the "unceasing motion of the steam-engine." In an establishment for spinning or weaving cotton, all the hard work is performed by the steam-engine, which leaves for the attendant no manual labor at all, and literally nothing to do in general, but at intervals to perform some delicate operation, such as joining the

* The quality of the light from different bodies will depend—all other circumstances being the same—on the qualities of the combustible body. The most intensely white light evidently contains a greater portion of olefiant gas than a dull yellow light. It is not, however, unworthy of remark, that very much depends on the management of the materials. A tallow candle, with a small compact wick, will yield a more brilliant light—I mean as to its quality—than a similar candle with a large fibrous wick. What is usually termed the perfect combustion of the materials is, in fact, only another term for the perfect combination of all the inflammable elements with oxygen.

† It may not be improper to remark, that when aqueous vapor exists in an inflammable body, as in alcohol and ether, there must of necessity be oxygen present. When, however, the vapor of this body is converted into gas (44), the oxygen does not act the part of a supporter; but by combining with half its volume of oxygen, yields carbonic oxide, which, under favorable circumstances, becomes, by the addition of another half volume of oxygen, carbonic acid.

threads that break, taking the cops off the spindles, &c. And it is so far from being true that the work in a factory is incessant, because the motion of a steam-engine is incessant, that the fact is, that the labor is not incessant on that very account, because it is performed in conjunction with the steam-engine. Of all manufacturing employments, those are by far the most irksome and incessant in which steam-engines are not employed; and the way to prevent an employment being incessant, is to introduce a steam-engine into it. And these remarks, strange as it may appear, apply peculiarly to the labor of children in cotton factories. Three-fourths of the children so employed are engaged in piecing at the mules, which, when they have receded a foot and a half or two feet from the frame, leave nothing to be done,—not even attention is required either from spinner or piecer, but both stand idle for a time, which, if the spinning is fine, lasts in general three-fourths of a minute or more. Consequently, in these establishments, if a child remains during twelve hours a day, for nine hours he performs no actual labor.* A spinner told me that during these intervals he had read through several books. The scavengers, who have been said to be "constantly in a state of grief, always in terror, and every moment they have to spare, stretched all their length upon the floor in a state of perspiration,"† I have seen idle for four minutes at a time, and certainly could not find that they ever displayed any symptoms of the condition described in this extract from the Report of the Factory Committee.

If we wish to discover occupations which are really laborious, irksome, and incessant, we must go to those trades in which, not only no steam-engine, but no machinery whatever, is used. The employment of milliners' girls is one of this description; they are engaged in it for a far longer period of time than the factory children; and I have it in evidence from medical gentlemen (page 120, First Report,) that their health is more seriously affected by it than that of persons in factories. Surely bending over a needle sixteen hours a day cannot be deemed otherwise than laborious, irksome, and incessant in the highest degree. But the case of the pin-headers is the most glaring instance of the absurdity of the principle that sets a brand on those trades alone in which steam-engines are employed. The unhappy children engaged in this business, who are of a far tenderer age than any in factories (as I have seen them working at it before they have reached their sixth year), have to sit twelve hours daily at a table, with their bodies continually bent in the form of the letter C, their eyes intently fixed upon the pin-heads, and both hands and feet in perpetual motion.

At Derby there is a magnificent establishment for making bobbin-net, in which the whole of the machinery is moved by a steam-engine. The same machines are used at Nottingham, with the difference that they are there mostly worked by hand, and consequently the labor is infinitely heavier. In the Derby factory the labor required is so slight and discontinuous, and the machine performs its work with such admirable precision, that many of the workmen were literally at sleep in their places when I visited the establishment; yet they are included in the Ten Hour Bill, while their Nottingham brethren are omitted. The master of the establishment complained of the serious loss he should sustain by the operation of the bill, and asked me what justice there was in subjecting his business to it, in which the labor of the workmen was evidently so light, while the hard-worked operatives in the factories of his Nottingham rivals were left untouched? I could not answer his question.

The most irksome employment connected with cotton-spinning is "picking" cotton for fine work, an operation which is generally performed by the youngest children in the following way: A fleece of cotton is hung up before the window, and the child standing constantly in the snme place, with its head about six inches from the fleece, picks out the particles of dust that are lodged in it. The wearisomeness of this occupation must be, beyond all comparison, greater than that of the piecers or scavengers, as the child cannot stir from its place, but must keep perpetually looking at a bit of cotton; but it is not assisted by the steam-engine, consequently it may be worked twenty-four hours, or any number of hours, without intermission, for any thing Lord Ashley's Bill says to the contrary. In the coarse factories this work is done by the steam-engine, and therefore the child who attends the operation has not a tenth part of the labor to perform which it otherwise would have. Here, then, it is protected by a factory bill.

Occupations which are assisted by steam-engines require for the most part a higher species of labor than those which are not;

* A piecer, however, generally attends two mules, whose motion is alternate, and then his leisure is six hours instead of nine.

† See Report of Factory Committee, page 325.

the labor of the head is then partially substituted for the labor of the muscles; in fact, it becomes in some measure skilled labor, and, like all skilled labor, is paid highly, as the tables of wages I have given prove. In no other way can I account for the comparative high wages which factory workmen, whether children or adults, obtain. "Batting" cotton seems by far the most laborious employment in a factory; it is performed entirely by women, without any assistance from the steam-engine, and is at least as hard as threshing corn, to which it has a great similarity; yet those engaged at it do not earn, on an average, more than 6*s.* 6*d.* weekly, while, close by, may be seen women, and even children of fourteen, earning double and treble that sum at stretching or power-loom weaving, in neither of which occupations is the labor one quarter as great. In power-loom weaving especially, the manual labor seems to be really nothing, as those who work at it frequently follow the motion of the lay by leaning on it with their arms, with the view of taking exercise; it is also the healthiest of mill occupations.—Were factory work in every department seriously detrimental to health, this circumstance would account for the high rate at which it is paid; but the evidence proves so strongly that such is not the case, that we are compelled to resort to some other explanation.

Shall I be better believed, when I state that I myself a short time ago was impressed with the common prejudice respecting steam-engines, viz. that employment at them tended to degrade a man into a machine, and deaden all the powers of his mind? The minute attention I have been compelled to pay to this subject in discharging the duties of this commission has convinced me that this is an idle and groundless notion, and in fact, in most instances, it is the reverse of truth. Whatever employments have this degrading tendency are among those in carrying on which no mechanical ingenuity has been applied: a workman of a superior class is always required to attend delicate or complicated machinery. Of course a child nine years old cannot be expected to display much skill in its work; but its education in factory labor must begin at that age, or it never can become a good skilled workman. Those who enter a mill at sixteen or seventeen always labor under great disadvantage, and earn comparatively little wages, from their inability to acquire that degree of tact and skill necessary to the due performance of factory work.

But the misrepresentations that have been put forth on the subject of the fine-spinning mills are perhaps the most extraordinary of all. I have no hesitation in saying that the labor in the fine-spinning mills of Manchester is lighter, pleasanter, and not less healthy, than in any other mills in the town. The lightness of the labor is owing to the slowness with which the machinery moves in spinning fine numbers. The mule in spinning No. 30 or 40 makes in general three stretches a minute; in the high numbers only one, and sometimes less. This fact I have ascertained with the utmost precision, by frequently timing the motion of the machine, holding a watch that marked the moments in my hand. During at least three-fourths of this minute, the piecers, five of whom usually attend two mules, each containing 360 spindles, have literally nothing to do; they then stand listlessly by, their attention engaged by any thing but their work, till the mule recedes, when they instantly proceed to piece the threads which break, or are purposely broken (as in fine spinning, if a knot is perceived in any part of the yarn, it is intentionally broken.) The piecing cannot take up long, as the mule has no sooner arrived at the frame than it instantly begins to advance, and when it has got about a foot and a half or two feet from the frame, it is impossible to reach over to the rollers, and the period of idleness begins. There is far less work for the scavengers to do in fine-spinning than in coarse, on account of the waste being so much smaller, and consequently this part of the business is usually done by one of the piecers. Another superiority which these establishments have over the coarse-spinning factories consists in the small quantity of dust that is evolved in every stage of the process; in fact, in the spinning-rooms there may be said to be no dust at all.

I was particularly struck with the portly appearance of many of the spinners in these establishments; and one of the fattest men I saw in Manchester was spinning No. 180 in Mr. Houldsworth's factory, and he had been engaged in this work seventeen years. Another whom I questioned had been a fine-spinner for thirty-six years, and he was employed in spinning No. 200 at the moment I spoke to him. One of the most violent witnesses for the Ten Hour Bill that I examined (Thomas Wilson, page 65, Second Report,) says that his health was much better when he worked in a fine-spinning mill than in a coarse. In short, the fine-spinning mills, which have been made the object of such deadly hostility, are, scientifically speaking, the glory of Manchester.

Nothing can exceed the beauty, delicacy, and ingenuity of the machinery, the order in which it is kept, or the extraordinary results it is capable of producing. I have seen cotton spun in them of the number 350; in other words, a pound of cotton is stretched to the incredible length of 294,000 yards, or 167 miles, and is then sold for twenty-five guineas, the original cost of it having been 3*s.* 8*d.* It is the only part too of the cotton trade in which England is absolutely unrivalled, as, with the exception of some attempts that have been made in France, no other nation can approach us in this department of manufacturing. The export of fine yarn is increasing more rapidly than of any other description of cotton goods. It is impossible to keep the coarse-spinning mills in the same order as the fine, owing to the greater dust occasioned by the work, and the machinery not being required of equal delicacy. They have, however, other peculiarities, which make them at least as worthy of attention. For instance, there is not unfrequently attached to them a department for power-looms, which are among the most extraordinary machines in a factory. I have stood by one of these looms, and minuted its operations with a watch, when I have seen it weave seventy-two square inches of cloth in a minute, without any human being attending to it. In factories thus furnished, the cotton enters in a raw state, and comes out as cloth; and of the numerous machines through which it has to pass, including the steam-engine which moves them all, there is not one that does not seem to demand the utmost stretch of human ingenuity to bring it to its present state,—not one that does not condense in its formation the result of at least a hundred patents, or that has not required in its invention the united efforts of at least a hundred minds.

Sailing against the Wind.—A correspondent of the United Service Journal offers the following suggestion: Let a ship be provided with sails, &c. like those of a windmill, which will be turned by the wind, and let the power thus acquired work a paddle-wheel: thus a power would be obtained from an adverse wind equivalent to that of steam. This apparatus should be employed on each side of the ship; it would not be extensive, it would be moveable, it may be taken to pieces and put together when wanted; and if successful, promises to be a most useful invention, as we should no longer hear of ships being detained for weeks in port, or delayed almost indefinitely on their voyage by adverse winds.—[London paper.]

The following letter of General Washington, addressed to a mercantile establishment in London, has been politely lent us to copy. The possessor of the original has had numerous offers for the MS. in London and in this country, which he has uniformly refused. He is now wishing to dispose of it; should any of our friends wish to possess such a relic, a line addressed to W. T., care of the Editor of the Mechanics' Magazine, New-York, will meet with every attention.

Mount Vernon, 10th August, 1760.

Gentlemen,—By my friend, Mr. Fairfax, I take the opportunity of acknowledging the receipts of your several favors that have come to hand since mine of the 30th Nov. last, and observe in one of them of the 14th Feb., by Crawford, that you refer to another by the same ship, but this has never appeared.

Inclosed you are presented with the mem. for receiving the interest of the Bank Stock signed as directed. The State not yet being so amply settled as it ought, an entire division has not been made, which leaves many matters upon an instable footing, and among the rest, the money in your hands, which has not yet been assigned to individuals, although I believe it will chiefly, if not all, fall into my part, since it best suits my purposes to have money that can be commanded than money at interest. However, till matters come to a more conclusive settlement you may let the accounts stand as you have stated them, charging each party with their own Drafts and Orders, and letting the Credits remain in favor of the Estate as a common Stock till further directions. The Tobacco ship'd per the Fair American, Cary, & Russia Merchant, may be applied the same way; but the present [growing] Crop will be ship'd on my own, and Jno. Parke Custis's particular accounts [each having our plantations allotted us,] and must be applied to our several credits as you will be directed—so must all the remittances hereafter to be made.

The Insurance on the Tobacco, per Talmon, was high, I think—higher than I expected; and here, gentlemen, I cannot forbear ushering in a complaint of the exorbitant prices of my Goods this Year, all of which are come to hand [except those packages put on board Hooper.] For many years I have Imported Goods from London, as well as other ports of Britain, and can truly say, I never had such a pennyworth before. It would be a needless task to innumerate

every article that I have cause to except against: let it suffice to say, that woollens, linens, nails, &c. are mean in quality, but not in price; for in this they excell, indeed, far above any I have ever had before. It has always been a custom with me when I make out my invoices, to estimate the charge of them; this I do for my own satisfaction, to know whether I am too fast or not, and I seldom vary much from the real prices, doing it from old notes, &c.; but the amount of your Invoice exceeds my calculations above 25 per cent., and many articles not sent that were wrote for.

I must once again beg the favor of you, never to send me any goods but in a Potomac Ship; and for this purpose let me recommend Capt. John Johnson, in an annual ship of Mr. Russels to this river. Johnson is a person I am acquainted with—know him to be very careful, and he comes past my door in his ship; I am certain, therefore, of always having my goods landed in good time and order, which never yet has happened when they come into another river. This year the Charming Polly went into Rappahannock, and my goods by her received at different times and in bad order—the Porter entirely drank out. There came no Invoice of Mrs. Dandridge's Goods to me; some suppose it was forgot to be Inclosd.

I was owing Mr. Knox, of Bristol, a balance of £51 5s. 11d., to discharge which, and be out of that Gentleman's debt, I shipd Mr. Farrel eight Hhds. Tobacco in April last, desiring him out of the proceeds to pay the above sum; but if in case [which I thought hardly possible] this Tobacco should be insufficient to answer this purpose, then for him to draw upon you for what it might fall short; you will please, therefore, to notice this; and Mrs. Fairfax having kindly undertaken to purchase something for Mrs. Washington, to the amount, I suppose of Fifty or Sixty pounds, I must likewise desire the favor of you to pay my order in his favor as soon as presented. When you have received the money for the inclosed bill, please to credit my account for it.

As I shall write to you again by the Fleet, I shall decline giving any directions about the Busts till then. Sometime ago there was a prospect of making a large crop of Tobacco this summer, but a series of wet weather for near a month with little or no Intermission has caused general complaints among the Planters, and now it is feared that the crops will be very short. The Tobacco in many places being under water and Drownd, and in others suffering much by the Spot, which is always a consequence of such rains.

My Steward on York river writes me that he has received the Goods ordered from Glasgow. Inclosed I address you the copy of a letter wrote from Williamsburg in April last, and in a letter of the 20th of June I advertised you of two drafts I had made upon you, the one in favor of Mr. Jno. Addison, for £364 19s. 0d., and the other of Mr. Will'm. Digges, for £304 15s. 3. These payments were in part for a valuable purchase I had just made of about 2000 acres of land adjoining this Seat—there are more payments yet to make, and possible I may have occasion to draw upon you for a further sum, though not more, I am well persuaded, than you have effects to answer. Yet if at any time a prospect of advantage should lead me beyond this a little, I hope there will be no danger of my bills returning. I mention this rather for a matter of information [In case such an Event] than as a thing I ever expect to happen, for my own aversion to running in Debt will always secure me against a Step of this nature, unless a manifest advantage is likely to be the result of it.

Since writing the foregoing I have added to my landed purchase, and shall have occasion in a few days to draw upon you to the amount of about £250 payable to Mr. Rob. Brent—save a bill of about £40 which will be passed in favor of Mr. Clifton.

I am, Gentlemen, Your Most Obedient,
Honorable Servant,
Go. Washington.

Meteorological Stone.—A Finland journal gives an account of a singular stone in the north of Finland, where it answers the purpose of a public barometer. On the approach of rain, this stone assumes a black or dark grey color, and when the weather is inclined to be fair, it is covered all over with white specks. This stone is, in all probability, an argillous rock, containing a portion of rock-salt, ammonia, or salt-petre, and absorbing more or less humidity in proportion as the atmosphere is more or less charged with it. In the latter case, the saline particles, becoming crystallized, are visible to the eye as white specks.

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